TPRS

Quarterly Report

The official journal of the leading regional amateur radio digital communications organization of the Americas

NOVEMBER 1999

Published by the Texas Packet Radio Society · Volume 14, Issue 2

President's Report

IN THIS ISSUE

President's Report
Tom McDermott, N5EG

No TPRS Fall symposium

There will not be a TPRS Fall Digital symposium this year due to a combination of factors: our sponsor is no longer at UT Austin, and the rest of us have been just too busy to set one up. This, coupled with the fact that the ARRL/TAPR Digital Communications Conference (DCC) now occurs late in the fall all conspire to squeeze the available time and facilities, and make it tough to sponsor.

TAPR FHSS SS Radio update

In the last QR we discussed some changes on the TAPR spread-spectrum radio design. A lot has happened in the 3 months since! As you may recall, Motorola cancelled production on the transmit modulator IC - thus we had to design a large FPGA to replace it. This was accomplished in 3 weeks time, and the new device has been simulated, placed, routed, and the I/O pins fixed. It's incredible what the Xilinx tools are capable of doing. The entire design update was done *without* the use of high-level languages or simulation languages (i.e. without VHDL or Verilog). Everything was done at the gate

(Continued on page 2)

TPRS

Quarterly Report

The TPRS Quarterly Report is published by the Texas Packet Radio Society, Inc. Materials submitted for publication will be published on a space-available basis. Unless otherwise indicated, explicit permission is granted to reproduce any material appearing herein, provided credit is given to both the author and to TPRS.

Address articles and correspondence to:
Texas Packet Radio Society
P.O. Box 50238
Denton, Texas 76206-0238

(Continued from page 1)

level. This means that your author was able to draw AND, NOR, XOR gates, and invoke macros (adders, registers, etc.) with a mouse, and have the entire design come together in a matter of days. This without going back to school to learn the basics of concurrent hardware languages.

The FIR filter designs were generated using a version of the Parks-McClellan software written at Rice University, which was extensively modified for the TAPR Wireless Digital book a couple of years ago. Also, Microsoft Excel was used to help optimize the truncation of the filter coefficients down to 10-bits width, and display the results. This allowed playing with the filter resolution until we achieved good out-of-band rejection, good in-band shape, all while minimizing the number of filter taps. The Xilinx software package automatically generates the filters from this information. Additionally, generating the numerical-controlled oscillator (NCO) and phase accumulator for the symbol recovery was done by just picking a few macros out of the Xilinx library, and wiring them together with busses. This was done in the matter of a few minutes! (Previously, we had done a far less sophisticated version in a different vendor's package that required capturing every single gate - a very tedious and slow task). It was quite surprising to see how fast all this could come together and yield a good functional simulation.

Using FPGAs to implement high-performance modems should become popular considering the speed and ease with which they can be designed and implemented, and the very high performance available with them. In our design, the FPGA is a RAM-based part, meaning that the configuration is "soft" -- it can be downloaded to the part, erased, and a revised version downloaded quickly without any hardware modifications.

Since then, there has been a design review on the RF board for the radio. A number of action items were taken and resolved in the last 4 weeks. The new board is about ready to go into layout. In the review process, we brought two additional people onto the project: Steve Bible, N7HPR, who will be

(Continued on page 3)

(Continued from page 2)
doing the PIC firmware; and Steve Ludvik, who works for the Dandin Group, he will be laying out and assembling the boards. Additionally, we re-designed the RF FWD/REFL power meter circuit to use matched high-sensitivity Schottky diodes. This circuit allows us to improve the sensitivity of he power meter while keeping the through-circuit losses very low. In addition, a number of parts that have been made obsolete by the manufacturer have been replaced with newer parts still in current production.

High-speed Ethernet Link

Much of the rest of this issue is dedicated to a discussion of a high-speed microwave Ethernet link. This was written by John Miles, who has graciously allowed us to reprint the details of his design in the TPRS QR.

-30-

IP Address Coordination

A question that TPRS gets asked from time to time is "who manages IP address assignments in my area"? The IP Class-A address 44.x.x.x was assigned to the amateur radio service many years ago. Class-A means that up to 16 million hosts can be assigned addresses within the 44 address space - the root name of this space is "ampr.org". The official administrator for the addresses is Brian Kantor, at UC San Diego. Brian has delegated the administration of IP addresses in various regions of the world to local administrators. One thing about ampr.org is that to be on it, you have to go through the 56Kb/s gateway at UCSD in order to reach the Internet. Some people have chosen to use a different domain and address in order to more directly reach the Internet.

A list of administrators is maintained sporadically on the TAPR website at: http://www.tapr.org/tapr/html/pkthome.html under TCP/IP stuff.

The direct link of administrators maintained at UCSD is:

ftp://ftp.ucsd.edu/hamradio/amprnets

The regional IP address administrators as of October 19, 1999 are:

44.110/18 USA:Arkansas WD5B Richard Duncan
44.030/18 USA:New Mexico KC5QNX Byron Hicks
44.078/18 USA:Oklahoma KB0QJ J. Frank Fields
44.028/18 USA:Texas: North W5CQU Larry Story
44.076/18 USA:Texas: South K5WH Walter Holmes
44.077/18 USA:Texas: West KA5EJX Rod Huckabay

To read the addresses: the code 44.028/18 means that the upper 18 bits of the IP address represent the network in question, while 14 bits (32-18 = 14) represent a particular host within that network. By using 18 bits in the network field (as opposed to 16 bits) more networks (but with fewer hosts per network) can be accommodated within the 44 administered region (i.e. 262,144 networks as opposed to 65,536 networks within 44.x.x.x).

It is envisioned that in future amateur radio several different models of IP address administration may emerge. The current paradigm is based on static addressing - IP addresses are assigned permanently. Another is based on dynamic addressing - in this model, your computer is temporarily assigned an IP address when it connects to a server. The address is reclaimed when you logout. While at one time fixed addresses were needed for many IP services, that is no longer the case. The sites that would need fixed addresses are those that provide 7x24 services - such as a mail server, or a web host.

An Experimental 10-Mbit/s Microwave Data Link

by John Miles, KE5FX and re-printed by permission. See the complete story on John's web site: http://www.qsl.net/ke5fx.

(Continued on page 4)

(Continued from page 3)

It's ironic that some of the most exciting development work in high-speed data communications within the Amateur Radio community was carried out many years before the birth of the World Wide Web and the popularization of the Internet as a vehicle for mass communication. As a case in point, N6GN's pioneering 2-Mbit/s microwave data link was first described in 1989. A decade later, everyone and his mother-in-law is chatting happily away on the packet-switched, ubiquitously-connected communications network we call the Internet, but little progress has been made towards realizing the benefits of high-speed data networking in the Amateur Radio realm.

My own purpose in developing a 10-megabit radio link was threefold: to explore the design techniques underlying high-bandwidth microwave communications; to do my part to help bring Amateur Radio into the twenty-first century; and, most important of all, to use my company's T-1 Internet service at home for free. :-) This page is intended to describe my work to fellow Amateurs and other experimenters for whom a 9600-bps packet BBS or 31-baud PSK rig just doesn't cut it. I've tried to describe the circuit and relevant construction techniques in depth, for those who may be interested in reproducing and/or modifying my work, but it should be made clear at the outset that such a project isn't a weekend endeavor for the electronics neophyte. While this isn't the most complex or demanding of projects, it has several unforgiving aspects that will not tolerate sloppy construction practices or inadequate care on the builder's part. You should be conversant with basic RF theory and construction skills before tackling it, or at least have access to one or two Elmers who have "been there and done that." You must have access to some basic electronic test equipment, including at a minimum a good oscilloscope and digital VOM. Finally, you should be prepared to commit the necessary resources of time and money to get the results you want. Underestimating the effort and expense required to get your project up and running is probably the #1 cause of failure.

(Continued on page 5)

Texas Packet Radio Society, Inc.

TPRS was founded in 1985 and is an educational, public service, and scientific research non-profit corporation. Texas Packet Radio Society goals are:

1- design and research amateur radio packet networks
2- provide education in the area of general packet usage

To accomplish better communications in the region, TPRS has been organizing statewide working groups to cover various networking topics. The current working groups are the Mailbox/BBS Group, TCP/IP Group, and the TexNet Support Group. TPRS hopes that these working groups will help promote information exchange in their respected areas in Texas. New working groups are formed as needed to provide channels for discussion and to help provide direction for that area of digital communications. Anyone can participate in a working group; TPRS membership is not required.

TexNet

TPRS has established a digital packet network protocol, a standard hardware package for the network nodes, and software modules that implement the TexNet network.

The basic design philosophy of TexNet is an open, inexpensive, multi-resource, high speed 'backbone' with access through multi-connect capable local nodes. On the high speed side, TexNet is a 9600 baud network system. For local access, compatibility with the typical 2 meter AX.25, 1200 baud, AFSK/FM station is the operational norm. Other baud rates and modulation techniques can be supported on the primary user port or secondary port. The system is totally compatible with both versions of the AX.25 protocol specifications for user connections. With these general specifications, TexNet has been designed and tested to enable all users to take advantage of this high speed, full protocol protected packet network system.

Each node offers, in addition to TexNet access, local area digipeater service, 2 conference bridges for full protocol protected roundtable or net operation, a full mult-connect, multi-user mailbox system, a local console for installation and maintenance setups, a debugger module for long distance and local software monitoring,and an interface for a weather information server for regional weather information, if available.

The NCP-PC (TexNet for PC) creates a direct interface to the PC platform. The Z80 based PC card supports 4 channels for communications. This co-processor approach allows the AX.25 and TexNet-IP to run on the card without affecting the PC. This allows the full power of the PC to be used for network applications. The versatility of this board is only now being developed and applications are endless.

The TexNet Network

The Texas TexNet network system has been operational since October 1986. When fully operational, the network reaches from the border of Mexico to Missouri. Use of the Texas TexNet system is open to all amateur operators. TPRS has been coordinating the installation of the Texas TexNet system. Further expansion of the system depends entirely upon the amateur community.

INFORMATION

TPRS is interested in spreading our information and research efforts as widely as possible. We want other groups involved with packet efforts to get in contact with us. We will provide information for those amateur packet groups that are interested in this system for their areas. If you would like more information concerning TPRS or TexNet, please drop a letter to:

Texas Packet Radio Society, Inc.
P. O. Box 50238
Denton, Texas 76206-0238

TPRS MEMBERSHIP

TPRS membership is widespread with most members located in Texas, but members are located in other states and in foreign countries. Membership is open to any interested person. If you are interested in becoming a member and receiving the TPRS Quaterly, please send your name, address and call with membership dues of $12 per year. A membership application is available elsewhere in this issue.

(Continued from page 4)

System Architecture and Limitations

The data radio described here has certain limitations that may make it unsuitable for use in certain applications. It's *extremely* important to understand the microwave link's limitations and overall architecture before assuming that it will work well in your situation. If your application meets the following criteria, there's a good chance that this is the project you've been looking for!

- **Point-to-Point Gunnplexer Communications**
  The link as described uses two prepackaged microwave transceiver modules, called "Gunnplexers." These modules are remarkably simple and reliable. They consist of three diodes, a resonant cavity, and an antenna aperture. One of the diodes, the "Gunn diode," generates RF energy at 10 GHz. Another, the "varactor diode," is used to vary the exact frequency of the emitted microwaves in accordance with the Ethernet signal to be transmitted. Finally, the third diode, known as the "mixer," is responsible for receiving the signal from the Gunnplexer at the other end of the link. Because it's impractical to carry out the necessary Ethernet signal-recovery operations at the Gunnplexer's native frequency of 10 GHz, the mixer diode actually delivers the recovered signal at an "intermediate frequency," or IF, at a more reasonable frequency of 145 MHz.
  Where, exactly, does this 145 MHz intermediate frequency come from? It turns out that the mixer diode can mix, or *heterodyne*, the transmitted signal from the Gunn diode in its own Gunnplexer with the signal received from the distant end, to yield the desired IF frequency. All that is necessary is to tune the two Gunnplexers to frequencies which are 145 MHz apart. In our case, we arbitrarily designate one Gunnplexer for operation at 10.178 GHz, with its counterpart tuned 145 MHz higher at 10.323 GHz. The exact frequencies are not important (and are, in any event, almost impossible to measure precisely without microwave test equipment), as long as one Gunnplexer is tuned 145 MHz below its counterpart at the other end of the link. This heterodyne effect is essentially available for free as a consequence of the design of the Gunnplexer transceivers, and it saves us a great deal of trouble in the design and construction of the rest of the link's circuitry.
  But there are also a couple of key drawbacks to this simple idea. One is that there is no easy way to allow more than two Gunnplexers to communicate with each other. The use of three or more Gunnplexers in a multipoint network topology would be mathematically impossible, since there is no way that three or more signal sources can all be 145 MHz apart from one another! Consequently, the design as presented here is useful only for connecting two machines or subnetworks.
- **Operation without Ethernet Collison-Handling**
  Another consequence of the twin-Gunnplexer heterodyne technique mentioned above is that each of the two stations can receive data correctly *only* when it is not attempting to transmit data at the same time. Since the link uses frequency modulation (or more properly, frequency-shift keying) to transmit Ethernet data, a station which is transmitting packet data is not going to serve very well as a local oscillator for mixing with the transmitted signal from the other station. Our intermediate frequency of 145 MHz is really just a "center frequency" -- the ones and zeroes from the Ethernet port appear as rapid variations in the exact frequency over a range of several megahertz. At any moment in time, the IF frequency at a given station is the difference in the microwave frequencies being broadcast from that station and its remote counterpart. So if a station is transmitting data, it cannot simultaneously receive data from the other

(Continued on page 6)

(Continued from page 5)

end because doing so requires that its own contribution to the IF frequency equation remains constant. This implies that Ethernet packet collisions will, in practice, be turned into lost or mangled packets.

Fortunately, Ethernet turns out to be remarkably tolerant of such abuse. Collisions only happen in the first place when one station begins transmitting a packet after another station has inspected the state of the network and concluded that no traffic is currently being passed, in preparation for transmitting its own traffic. They are a normal part of life in the world of Ethernet, and generally become more and more frequent with increasing network traffic. When a collision is sensed by a fully-compliant Ethernet transceiver, the ultimate result is retransmission of the data packet that caused the collision in the first place. Retransmission also takes place in the TCP/IP protocol when a packet is corrupted or lost altogether, so the effect of our link's behavior is simply to turn one type of packet-loss condition into another.

The distinction between lost packets and collisions is chiefly one of error-recovery performance. A lost packet is recognized as such only after a timeout period expires without acknowledgement of the packet's receipt at its destination. This period may range from milliseconds to seconds, according to the whims of TCP/IP and any other reliable-delivery protocols that the application may be employing. A packet which is involved in a collision can be caught instantly by an Ethernet-compliant transceiver and retransmitted in a more timely fashion, compared to one which is consigned to the proverbial bit bucket by our radio link. By failing to respond to packet collisions in a manner compliant with the Ethernet specifications, our link is theoretically vulnerable to performance losses that would not be a problem with a conventional hard-wired connection. In practice, however, with three machines at one end and eight at the other end of a single busy 10/100-megabit collision domain, we have not noticed any such dgradation in either latency or throughput, despite running critical real-time applications on a near-constant basis.

It's undoubtedly possible to design a separate signalling mechanism for reporting collisions to the AUI collision-sense input, along with the necessary circuitry to detect the occurrence of collisions in the first place. Perhaps the best solution for unusally collision-sensitive applications is to eliminate as many collisions as possible in the first place, by using a pair of switching hubs or bridges to partition the subnetworks at the two ends of the link into separate collision domains. To date, I have not run across any situations that warrant further action along these lines.

- **Connectivity with Ethernet Hardware via 10-Mbit/s Attachment Unit Interface (AUI)**

It's tempting to press the ubiquitous 10BaseT interface provided on inexpensive network cards and hubs into service as the interface to a wireless data link. Unfortunately, though, another consequence of the Gunnplexer-based signal mixing technique is that transmitted data appears not only at the receiver at the remote end of the link, but at the local receiver as well! A few moments' thought will reveal that this is really the same problem that deprives us of a meaningful collision-sensing mechanism as described above. Because the intermediate frequency containing our recovered data is simply the difference frequency between the two transceivers, it doesn't matter *which* Gunnplexer does the transmitting -- the resulting frequency shift will appear in the IF signal at both stations. We're essentially caught in a no-man's-land between half-duplex and full-duplex communications. Although 10BaseT is physically capable of full-duplex operation, it's really

(Continued on page 7)

(Continued from page 6)

a half-duplex signalling system, logically speaking. 10BaseT consists of two signalling pairs -- a receive pair and a transmit pair. Any activity on the receive pair while transmission is in progress is interpreted as a collision, even if that activity is just a locally-generated echo of the transmitted signal. Some Ethernet hardware may be configurable to overcome this limitation under particular circumstances, but in the general case 10BaseT is simply the wrong interface standard for a system such as this one.

Enter the AUI port, or *Attachment Unit Interface*. Created especially as a general-purpose interface for Ethernet transceivers of every stripe, the AUI standard uses a DB-15 connector and comprises three signalling pairs: receive, transmit, and collision. The AUI port is ideal for our purposes, as it not only permits a locally-generated echo at its receive pair, but actually expects it. AUI signal levels and impedances are not greatly different from 10BaseT. AUI signals are somewhat lower in amplitude, and the Ethernet specification calls for shielded twisted-pair (STP) cabling to be used for connections to the AUI port, but I've had no problems connecting the transceivers to AUI ports with 15 to 20 feet (5 to 7 meters) of conventional Category 5 UTP cabling. The AUI ports's third (collision) pair is simply left unconnected.

It's a little bit harder to find Ethernet cards and hubs with AUI ports, and they tend to be more expensive than similar gear equipped only with RJ-45 jacks for 10BaseT, but there are still plenty of bargains to be had. The prototype transceiver pair is connected to two LinkSys Enterprise Ethernet hubs featuring AUI ports and 16 RJ-45 jacks, purchased at CompUSA for about $150 each. In principle, 10BaseT could be used as the interface to the transceivers if a latching mechanism were designed to suppress the local echo, but the AUI port is definitely the way to go if possible.

- **Availability of an Unobstructed Line-of-Sight Path**

  This is a particularly important point to consider when planning your installation. Microwaves travel in a line-of-sight path and are easily blocked by buildings, large trees, or other landscape features. Additionally, large surfaces near or within the signal path may cause multiple delayed reflections of the transmitted signal to arrive at the receiver, in a manner similar to the "ghosting" sometimes observed on over-the-air TV signals. These multipath reflections, if strong enough, may cause data corruption. (On the other hand, a large planar surface such as the side of a building can also be used intentionally as a reflector if a good direct path proves impossible to achieve!) The transceiver units described here are equipped with large, easy-to-read signal strength meters to aid in optimizing the path, but keep in mind that multipath distortion can render even a strong signal unusable.

  Try to locate both transceiver units outdoors, so that the antennas face each other with no intervening obstructions such as windows. Many office windows are made with metallized coatings for energy-efficiency, which is bad news in the microwave business. One of my transceivers is located just inside a thick glass window that adds over 10 dB of loss to an otherwise-excellent 10 GHz path. In other words, 90% of the signal power is wasted on the trip through the window. If you find you must aim your transceivers through a window, try to keep the path as close to perpendicular to the window surface as possible to minimize attenuation. Transceivers located outdoors must be appropriately weatherproofed. This can be as simple as a layer or two of polyethylene sheeting or even a trash bag over the unit. Thin layers of plastic over the antenna aperture don't cause appreciable signal loss.

(Continued on page 8)

(Continued from page 7)

For more information about signal-path planning and loss calculations, I'd recommend a look at The ARRL UHF/Microwave Experimenter's Manual. Select the "VHF/UHF/Microwave Communications" link on this page for a description of this and other good references.

Design and Construction Notes

In the following discussion, refer to the system block diagram and overhead view to learn how the transceiver modules are interconnected.

- **Antenna Considerations**

  No radio is better than its antenna. Adding a better antenna to a communications system is analogous to putting a race car on a weight-reducing diet -- it's the single best way to increase performance in almost every parameter. Before you increase the power of your transmitter, use exotic devices to optimize your receiver's noise figure, or otherwise throw money or engineering effort at a signal-strength problem, you should first make sure your antenna system is the best it can be. Fortunately, one of the biggest advantages offered by microwave radio communications is also one of the smallest ones -- antenna size! It's not difficult to achieve effective radiated power (ERP) levels of several watts or more using 10-milliwatt Gunn diodes, since a 1- or 2-foot dish antenna is electrically "large" at these ultra-short wavelengths. You can reasonably expect reliable operation of the radio link over *several miles* if proper attention is paid to antenna design and aiming.

  Although dish antennas are clearly the best choice when maximum range is the goal, they aren't likely to be necessary for links which span less than a mile (1.6 km) or so. The prototype transceivers use homemade horn antennas fabricated according to a 1:1-scale template generated by Paul Wade, N1BWT's excellent HDL_ANT antenna-design program. Here are two ready-to-build designs suitable for use with the M/A-Com 10 GHz and 24 GHz Gunn transceivers, respectively. Initial testing and alignment of the link can be accomplished with no antennas at all, but unless you are contemplating extremely close-range work (less than a hundred feet or so with no obstructions) you will want to fabricate horn antennas for your transceivers. You should observe about 5 dBi (i.e., 5 dB of gain over an isotropic radiator in free space) with the "naked" Gunnplexer apertures alone, and about 8-10 dB of additional gain with the 15 dBi 10 GHz horn mentioned above. To construct each horn as shown in the photo, I used sheet brass obtained from a local hobby shop, scoring the inner seams with a Dremel tool to allow the antenna to be folded together origami-style, and soldered the remaining seam. There were plenty of leftover scraps available for mounting the antenna to the Gunn transceiver aperture. It's important to achieve a tight fit between the antenna and aperture -- don't let the small end of the horn "float" too far off the Gunnplexer's mounting surface. N1BWT's latest page has a great deal of knowledge in store for those who are interested in optimizing microwave antenna performance, especially his online Microwave Antenna Book.

  The financially well-endowed may choose to go with a commercial standard-gain horn antenna such as the HWR-90 model sold by Microtech, Inc., but their price of U.S. $400 each will likely send most experimenters reaching for their dust mask, safety goggles, and Dremel tool instead.

Editor’s note: We would like to thank John for allowing us to re-print part of his article here.

If you are interested in further reading and constructing your own system, please continue on John’s web site: http://www.qsl.net/ke5fx.

TPRS Node Assigments
Official Publication: August, 1999
Subject to Corrections/Additions/Deletions.

X = ACTIVE/COMPLETED
T = ACTIVE/TEST
P = PENDING

Nr	Status	City/Town	Alias	Call	User Port	Remarks
3	X	Dallas	TEXNET	WR5C	145.05	PMS
2	T	Richardson	TESTBED	W9DDD	None	R&D
	T	Richardson	RICH	W9DDD	None	R&D
1	X	Murphy	MURPHY	N5EG	145.09	
5	P	Austin	NWS	Unkn	None	Weather PMS
6	P	New Braunfels	STXWX	N5IUT	145.05	Weather PMS
7	X	Boerne	BOERNE	N5VUO	145.01	
8	X	Geronimo	GERONMO	WB5NSN	145.07	PMS(AKA GERLNK)
9	X	Austin	AUSTIN	WA5LHS	145.07	
11	X	San Antonio	ALAMO	N0CCW	145.09/223.50	
12	X	San Antonio	SALAMO	WA2MCT	None	
13	X	Denton	DENTON	W5NGU	145.03	
14	P	Lubbock	LUBBOCK	KC5KQF	145.05	
15	P	Midland	MIDLAND	WB5RXA	145.05	
16	X	Greenville	GREENVL	K5GVL	145.07	
17	P	Midland	MAFDXC	WF5E	223.58	DXCluster port
19	X	Rockport	ROCPRT	N5JKH	144.99/446.1	
20	X	C. Christi	CORPUS	N5XCH	145.05	
21	X	Pettus	PETTUS	KA5BWL	147.56	
23	P	Lubbock	LBBDXC	KA5EJX		DXCLUSTER
24	X	Austin	AUSDXC	K5TR	144.99	
25	X	Austin	ARESTC	W5TQ	145.73	
26	X	Victoria	VCTRIA	W5DSC	145.01	
27	X	Alice	ALICE	K5DYY	145.07	
28	P	Amarillo	AMARILO	WD5ILA	145.05	
29	P	Abilene	ABILENE	WB5EKW	145.05	
34	X	San Antonio	SANTEX	WB5FNZ	223.58	
42	X	Kingsville	TAMUK	W5ZD	144.91	(aka KINGVL)
43	P	Bryan/CollStn	SBRAZOS	KF5LN	145.05/446.10	
44	P	Bryan/CollStn	NBRAZOS	KG5ZD	446.1	(See Nr 43)
45	P	Fannin County	FANNIN	WB5RDD	145.05	
46	X	Sherman	SHERMAN	WB5CVR	144.91	
47	P	South Dallas	SDALLAS	KF5RN	None	
48	X	Waco	WACO	WD5KAL	145.09	
49	X	Falfurrias	FALFUR	WB5FRO	None	
50	X	Mercedes	VALLEY	W5RGV	144.60	DXCluster port 2
51	X	San Isidro	ISIDRO	K5RAV	None	
52	X	Brownsville	BROWX	K5RAV		NWS node
73	X	Fort Worth	FTWORTH	N5AUX	144.99	
80	T	AOHTST	AUSTIN	WB5AOH	None	R&D AUSTIN
95	T	TNC95	AUSTIN	WB5AOH	None	R&D AUSTIN

TPRS Node Assigments
Official Publication: August, 1999
Subject to Corrections/Additions/Deletions.
(Continued)

(100-150) Reserved for TexLink Node Usage

Nr	Status	City/Town	Alias	Call	User Port	Remarks
105	X	Floresville	FLORES	WD5DOE	None	
109	X	Refugio	REFUGIO	WB5OLT	None	
118		Moody	MOODY	W5ZDN	440.1	

(151-249) Reserved for Non-Texas Node Usage
(150-159) Reserved for Louisiana

151	P	Lafayette LA	LFTDXC	N5SYF		
152	P	BatonRouge LA	BTRDXC	N5VWM		
153	P	Maxie LA	MAXIE	K5USL		
160	X	Ft Gibson OK	FTGIBSN	N5GIT	145.01	
161	X	Muskogee OK	MKOTST	WA5VMS	446.5 PMS	
162	X	Muskogee OK	MUSKOGE	W5EJK	145.09	
164	X	Lincoln AR	FAYETVL	K5VR	145.69	
165	X	Clayton OK	CLAYTON	W5CUQ	145.03	
166	X	Ft Smith AR	FTSMITH	W5ANR	144.91	
168	X	Tulsa OK	NWTULSA	W5IAS	145.03	
169	X	Tulsa OK	TULWX	N5WX	NWS WX Server	
172	X	Okemah OK	OKEMAH	WB5HLR	145.69	
173	X	Choctaw OK	CHOCTAW	K5CAR	145.69	
174	?	Prarie Grove AR	HOGEYE	K5FXB	None	
175	X	Garfield AR	GARFLD	WB2ROC	None	
176	X	Aurora Missouri	OARSMO	K0SQS	145.05	
177	X	Mt Magazine AR	MAGAZIN	KF5XB	144.95	
178	X	Russelville	RSLVL	WB5BHS	UNKN	
179	X	Little Rock AR	LROCK	WB5SQK	144.97	PORT 2
446.50(FUTURE)						
209	T	Little Rock AR	LRTST	KA5SQK	TEST Node	

(250-255) Network Reserved

If you are a TexNet node opearator/owner and have a correction to make to the list, advise to N0CCW@K3WGF.#STX.TX.USA.NOAM, or leave a message for N0CCW on the NDALLAS PMS of TexNet.

TPRS Membership Application

Name ______________________________ Callsign _______________
Address ____
Apt. or Mailstop ___________________
City/State ____
Zip _______________________ E-mail address __________________
Evening Phone (   ) __________ Work Phone (   ) _____________

Membership is $12 per year. How many years are you paying for? ____

☐ New Member ☐ Renewal

Make check payable to: Texas Packet Radio Society

FOLD HERE

PLACE
STAMP
HERE

ATTN:
Membership

Texas Packet Radio Society
P.O. Box 50238
Denton, Texas 76206-0238

Texas Packet Radio Society, Inc.

An Experimental 10-Mbit/s Microwave Data Link

No TPRS Fall Digital Symposium This Year

Be sure to visit the TPRS web page:
http://www.tprs.org
for the latest information on TPRS activities.

A current listing of Packet nodes, frequencies, and networks is located in the **North American Digital Systems Directory (NADSD) on-line at:**
http://www.tapr.org/directory/index.html

Texas Packet Radio Society
P.O. Box 50238
Denton, Texas 76206-0238

ADDRESS CORRECTION REQUESTED

To: